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(71)Applicant : **EASTMAN KODAK CO**
(72)Inventor : **ANAGNOSTOPOULOS CONSTANTINE N**
HAWKINS GILBERT A
DELAMETTER CHRISTOPHER N

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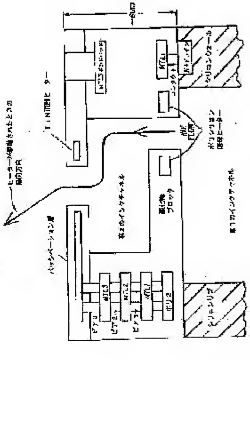
(54) INCORPORATION OF SUPPLEMENTARY HEATER IN INK CHANNEL OF CMOS/MEMS INTEGRATED INK JET PRINT HEAD, AND METHOD OF FORMING SAME



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a print head in which a polysilicon layer formed by CMOS process can be used as a heater on the bottom of an oxide layer in order to preheat ink in an ink channel before the ink at the nozzle opening reaches a top heater region.
SOLUTION: An ink jet print head is formed of a silicon substrate that includes integrated circuits formed therein for controlling operation of the print head. The silicon substrate has a series of ink channels formed therein along the length of the substrate. An insulating layer or layers overlying the silicon substrate has a series of nozzle openings or bores formed therein along the length of the substrate and each nozzle bore communicates with a respective ink channel. A primary heater element is associated with each nozzle bore for asymmetrically heating the ink in the nozzle bore. A secondary heater element is

provided upstream of the primary heater element and formed in the insulating layer to preheat ink just prior to entry of the ink into the nozzle bores.

CLAIMS

[Claim(s)]

[Claim 1]It is an insulation layer or a group supported on a silicon substrate which has an ink channel, and; board including an integrated circuit for controlling an operation of the print head, An insulation layer or a group which has an ink jet nozzle boa group which is formed in accordance with the length direction of a substrate, and is open for free passage to an ink channel; which ink-drops let is printed so that it may determine selectively. The 2nd heater element that preheats ink before it is formed in the 1st heater element,; insulation layer, or group formed near the boa and ink goes into a nozzle boa, in order to give heat asymmetrically to ink in a nozzle boa, and an ink jet printing head provided with;.

[Claim 2]It is the stage of heating ink asymmetrically in a nozzle boa in order to control an injection direction of a stage which equips with liquid ink an ink channel formed in a silicon substrate which has a series of integrated circuits formed in order to control an operation of the print head under a pressurization state, and; ink DOROPU let, By each nozzle boa being open for free passage to an ink channel, just before a stage and; ink which are performed with the 1st heater element that approached a nozzle boa and has been arranged go into a nozzle boa, unsymmetrical heating, A stage of preheating ink using the 2nd heater element, and a method of operating a continuation ink jet printing head provided with;.

[Claim 3]It is the stage of preparing a silicon substrate which has an integrated circuit for controlling an operation of the print head, A silicon substrate has an insulation layer or a group on it, and an insulation layer or a group to a stage,; insulation layer, or a group which is what has the conductor electrically connected to a circuit formed in a silicon substrate. In a stage,; insulation layer, or a group to form, a series of nozzle boa groups near the nozzle boa, In a nozzle boa. Ink. The 1st heater element to heat. A stage which forms an opening for ink to flow near a stage to form and the 2nd heater element arranged in a position of the upstream of ink included in; nozzle boa, a stage which forms an ink channel in; silicon substrate, and a method of manufacturing a continuation ink jet printing head provided with;.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the field of a digital control printer. In particular, a multiplex nozzle is accumulated on a single board and it is related with the liquid ink print head as which the drops of a fluid are chosen by a thermoforming means for printing.

[0002]
[Description of the Prior Art]Ink jet printing is recognized as a rival who was prominent in the digital control electrostatic printing field for a non-shock, the low noise characteristic, and the simplicity of a system. For this reason, the ink-jet printer has stored a success commercially in use at home (home), use in an office, etc.
[0003]An ink jet printing machine style can be made into either of continuation (CIJ) or drops (DOD) on demand, and can be classified. 1970 -- Keyser (Kyser) ** -- patented U.S. Pat. No. 3,946,398 impresses high tension to a piezoelectric crystal, bends a crystal by it, and is indicating the DOD ink-jet printer which gives a pressure to an ink sump and spouts the demanded drops. The piezoelectric DOD printer has stored a success commercially in the object for homes, and the picture (image) resolution of 720 or more dpi for offices. However, the high-voltage-driving circuit where an ink jet printing machine style is usually complicated, and the bulky piezoelectric crystal array are needed, and they are disadvantageous in the number of nozzles per unit length of the print head like the length of the print head.
[0004]1979 -- and -- (Endo) ** -- for the British patent No. 2,007,162 by which the patent grant was carried out, the electric heat drops ink-jet printer on demand which gives a power pulse to the heater which carries out heat contact at the water-based ink of a nozzle is indicated. A little ink evaporates immediately and forms the bubble which makes ink drops ejected from a small caliber along with the edge of a heater substrate. This art is publicly known as a heat ink jet or a bubble jet (registered trademark).
[0005]A heat ink-jet printer generates energy pulse with a usually sufficient heater to heat ink to the temperature of about 400 ** used as the reason of quick formation of a bubble. An elevated temperature required for this device needs use of special ink, complicates drive erection NIKUSU, and promotes degradation of a heater element via the cavitation (cavitation) and Kogation (kogation). A Kogation is accumulation of a wrap ink combustion by-product about a heater in debris (debris). The lump of such debris reduces the thermal efficiency of a heater, and, thereby, shortens the operating life of a printing (printing) head. The high activity power consumption of each heater bars manufacture of the page wide print head by the fall of a manufacturing cost at high speed.
[0006]It goes back in itself [continuation ink-jet printer] till at least 1929. the year -- hansel (Hansell) ** -- the U.S. Pat. No. 1,941,001 specification by which the patent grant was carried out should be seen.
[0007]March, 1968 -- sweet (Sweet) ** -- electrification of the ink drops printed is carried out selectively, and the U.S. Pat. No. 3,373,437 specification by which the patent grant was carried out is indicating the array of the continuous ink jet nozzle deflected to a

recording medium. This art is publicly known as binary deviation continuation ink jet printing, and it is used by two or more manufacturers containing the elm jet (Elmjet) and SAITEKKUSU (Scitex).
[0008]a U.S. Pat. No. 3,416,153 specification -- December, 1968 -- Hertz (Herts) ** -- a patent grant is carried out. This patent is indicating the method of realizing the printing (printing) spot of good light variation study density in continuation ink jet printing. The static electricity distribution of a drops stream (flow) by which electrification was carried out is committed so that the number of the DOROPU let (glob) passed through a small caliber may be modulated. This art is used in the ink-jet printer made from iris (Iris).
[0009]"METHOD AND APPARATUS FOR CONTROLLING THE ELECTRIC CHARGE ON DROPLETSAND INL JET RECORDER INCORPORATING THE SAME." The patent grant of the U.S. Pat. No. 4,346,387 specification of the name of ****** is carried out to Hertz on October 24, 1982. In this patent, the CIJ system which controls the electrostatic charge on DOROPU let is indicated. In the point arranged in the electrostatic electrification tunnel which has an electric field forming [drops], DOROPU let is formed by dividing the pressurized liquid stream (division). Drops formation is performed at a certain point in the electric field corresponding to the predetermined electric charge for which it asked. In addition to carrying out electrification of the tunnel, a deviation plate is used for actually deflecting drops. in the Hertz system, electrification of the generated DOROPU let is carried out (being able to give an electric charge), and it ranks second -- a throat opening (gutter) -- or to deviate on print media is needed. Electrification and a deviation mechanism are bulky and restrict the number of nozzles per print head severely.
[0010]The electrostatic electrification tunnel arranged to the neighborhood of a point in which all the conventional continuation ink jet art is various modes, and drops are formed in a stream till these days was used. In a tunnel, electrification of each drops may be carried out selectively. Electrification of the selected drops is carried out and they are downstream deflected by the existence of a deviation plate which has big potential difference. Electrification drops are intercepted, it is usually used in order to establish non-print mode, and on the other hand, non-electrification drops collide with a recording medium freely by print mode, and a throat opening (it is also called a "catcher") deflects an ink stream (flow) in the "non-printed" mode and "printing" mode in this way.
[0011]Recently, the new continuation ink jet printer system which makes unnecessary an above-mentioned static electricity electrification tunnel was developed. It works so that (1) DOROPU let formation and the function of (2) DOROPU let deviation may be combined better. This system CHOREKKU (Chwalek), Jeanne Moray (Jeanmarie), By ANAGUNOSUTOPOROSU (Anagnostopoulos) and others. It is indicated in the U.S. Serial Number 6,079,821 specification of the name of an invention of "CONTINUOUS INK JET PRINTER WITH ASYMMETRIC HEATING DROP DEFLECTION" for which it applied. These contents are included in the contents of this specification. In this patent, the ink control device in a continuation ink-jet printer is indicated. A device is provided with an ink sending channel, the source of compression ink which is open for free passage to this ink sending channel, and the nozzle which has the boa which carried out the opening to the ink sending channel. Here, the consecutive stream of ink flows out of an ink sending channel. An ink stream will be decomposed into the position estranged from the nozzle synchronizing with the impression thermal pulse by two or more

DOROPU let if a weak thermal pulse is periodically impressed to a stream with a heater. DOROPU let is deflected by the thermal pulse which increased from the heater (it can set by the boa of a nozzle). A heater has the section started selectively, for example, the section relevant to some boas of a nozzle. call specific selection starting of a heater section asymmetry (anisotropic) impression of the heat to a stream -- a ****** thing is made to continue This direction that acts so that heat may be impressed asymmetrically and the ink drops between the "printing" direction (on a recording medium) and the "non-printed" direction (direction which returns to a "catcher") may especially be deflected can be carried out by turns by carrying out a section by turns. CHOREKKU's and others patent provides the fluid printing system greatly improved in the direction which conquers the conventional problem about the number of the nozzles per print head, print head length, power use, and the helpful characteristic of ink.

[0012]Impression of unsymmetrical heat leads to the deviation of a stream, and it depends for the size on the quantity of two or more factors, for example, the geometric arrangement of a nozzle, and the thermal characteristic, and the added heat, the impressed pressure, and physicochemical / thermal characteristic of ink. Although solvent (especially alcohol) ink has very good deflection patterns and high ********** is realized in the continuation ink-jet printer with which different direction heating was carried out, a water-based ink is a problem further. The operation is not solid although a water-based ink is seldom deflected. In European patent No. 1,110,732 for which it applied to DERAMETTA (Delametter) and others, in order to improve the size of an ink DOROPU let deviation in a continuation ink jet different direction heating printing system, The continuation ink-jet printer which has an ink-drops deviation especially to a water-based ink with the geometric obstacle within an ink sending channel by providing the plane direction flow property by which enhancing was carried out is indicated.

[0013]the invention indicated here manufactures the continuation ink jet printing head for which it was suitable to the low cost maker -- or -- suitable -- a page -- it is wide and is based on work of CHOREKKU and others, DERAMETTA and others to the print head which can be made.

[0014]Although the ink jet printing head which is not considered to be the page wide print head is used for this invention, It is widely recognized as required to the improved ink jet printing system, For example, it has an advantage about the simplicity of the composition in cost, size, speed, quality, reliability, small nozzle orifice size, small drop size, low-electric-power use, and an operation, endurance, and production capacity.In this point, it is necessary about especially the capability to manufacture a page wide high-resolution ink jet printing head. The word of "page wide" has called the print head with a minimum length of about 4 inches so that it may be used here. High resolution means the nozzle density of a maximum of about 2,400 nozzles per unit inch from a minimum of about 300 nozzles per unit inch to each ink color.

[0015]In order to utilize the page wide print head enough to increase of press speed, the print head contains most number of nozzles. For example, the conventional scanning print head only had a nozzle of 100 numbers per 1 ink color. The 4-inch page wide print head suitable for printing of a photograph has no less than several 1000 nozzles. While being slowly scanned for the necessity that the print head moves it mechanically over 1 page, it is stood still, paper moves and the page wide print head passes the print head. Theoretically, a picture can be printed with one path (passage) and, thereby, increases

press speed substantially.
[0016]a page -- there are two big difficulties in realization of the ink jet printing head of a wide high throughput. By center distance between centres, to a 10 to 80-micrometer order, a nozzle must adjoin mutually and must arrange [1st]. The driver who supplies electric power to a heater the 2nd, and the electronics which controls each nozzle must be accumulated on each nozzle. It is because the trial which makes the terminal area of several 1000 bonds to an external circuit or other types is still difficult to realize now.
[0017]Law is a thing coping with these challenges for which the print head is formed on a silicon wafer using VLSI art, and a nozzle is accumulated on CMOS on the same silicon substrate on the other hand.
[0018]In order that the custom-made process proposed by the U.S. Pat. No. 5,880,759 specification by which the patent grant was carried out to silver block (Silverbrook) might form the print head, were developed, but. It is preferred that form a circuit first, rank second from a viewpoint of cost and production capacity using a Standard C MOS process mostly with the conventional VLSI equipment, and another MEMS equipment for formation of a nozzle and an ink channel performs post-processing of a wafer.
[0019]
[Means for Solving the Problem]The purpose of this invention is to provide a CIJ print head manufactured by production capacity which is low cost and was improved as compared with a conventionally publicly known ink jet printing head which needs custom-made processing more.
[0020]In order to preheat ink of an ink channel before other purposes of this invention are CIJ print heads characterized by a flat print head surface structure and ink arrives at a top heater field in a nozzle orifice or a boa, It is providing the print head which can use as a heater a polysilicon layer or other materials which were formed by a CMOS process at the pars basilaris ossis occipitalis of an oxide layer.
[0021]In the 1st mode of this invention, are an ink jet printing head and this ink head, It is an insulation layer or a group supported on a silicon substrate which has an ink channel, and; board including an integrated circuit for controlling an operation of the print head, An insulation layer or a group which has a series of ink jet nozzle boa groups which are formed in accordance with the length direction of a substrate, and are open for free passage to an ink channel; which ink-drops let is printed so that it may determine selectively. In order for a nozzle boa to give unsymmetrical heat to ink, before it is formed in the 1st heater element,; insulation layer, or group formed near the boa and ink goes into a nozzle boa, it has the 2nd heater element and; which preheat ink.
[0022]In the 2nd mode of this invention, are a continuation ink jet printing head the method of operating, and a :this method, It is the stage of heating ink asymmetrically with a nozzle boa in order to control a stage and; ink DOROPU let injection direction which equip with liquid ink under a pressurization state an ink channel formed in a silicon substrate which has an integrated circuit of a series formed for accumulating and being alike which controls an operation of the print head, Each nozzle boa was open for free passage to an ink channel, and unsymmetrical heating is provided with a stage and; which use the 2nd heater element and preheat ink just before a stage and; ink which are performed with the 1st heater element that approached a nozzle boa and has been arranged go into a nozzle boa.
[0023]In the 3rd mode of this invention, are a continuation ink jet printing head the

method of manufacturing, and a :this method, It is the stage of preparing a silicon substrate which has an integrated circuit for controlling an operation of the print head, A silicon substrate has an insulation layer or a group on it, and an insulation layer or a group to a stage,; insulation layer, or a group which is what has the conductor electrically connected to a circuit formed in a silicon substrate. In a stage,; insulation layer, or a group to form, a series of nozzle boa groups near the nozzle orifice, It has a stage which forms an opening for ink to flow near a stage which forms the 1st heater element for heating ink in a nozzle orifice, and the 2nd heater element arranged in a position of the upstream of ink included in; nozzle boa, a stage which forms an ink channel in; silicon substrate, and;.

[0024]If a drawing which showed like illustration of this invention and expressed is referred to, the following detailed explanation depends these purposes and other purposes, the feature, and an advantage of this invention, and they are clear to a person skilled in the art.

[0025]

[Embodiment of the Invention]Although especially this specification explains the claim which points out the principal part of this invention and is asserted clearly, he should understand this invention more deeply from detailed explanation of the following modeled after an accompanying drawing. Drawing 1 is an outline part plan of the print head constituted by this invention, and; drawing 1 A, Are the "notch" type heater for CIJ print heads by this invention an outline top view of the nozzle which it has, and; drawing 1 B, Are the split type heater for CIJ print heads by this invention an outline top view of the nozzle which it has, and; drawing 2, Are the "notch" type heater which met the B-B line of drawing 1 A a sectional view of the nozzle which it has, and; drawing 3, Corresponding to a 1st embodiment of this invention, are the outline sectional view which met the A-B line of drawing 1 A, are a shown figure the nozzle region immediately after all the ends of a conventional-type CMOS manufacturing stage, and; drawing 4, Are the outline sectional view in the nozzle region after demarcating a big boa to an oxide block using the device shown in drawing 3 which met the A-B line of drawing 1, and; drawing 5, Are the outline sectional view which met the A-B line in the nozzle region after deposition of deposition and flattening of a sacrifice layer, passivation, and a heater layer, demarcation, and formation of a nozzle boa, and; drawing 6, It is the outline sectional view which met the A-B line in the nozzle region of ** after forming the ink channel in the silicon wafer and removing a sacrifice layer, and; drawing 7 is an outline top view of the small array of the nozzle formed using the manufacturing method shown by drawing 6, Are a shown figure the central rectangle ink channel formed in the silicon substrate, and; drawing 8, Are the same figure as drawing 7, are a shown figure the rib structure which separates each nozzle, strengthens the intensity of structure and reduces the wave action in an ink channel and which was formed in the silicon substrate, and; drawing 9, Are the outline sectional view which met the B-B line in the nozzle region of drawing 1 A after demarcation of the oxide block for [corresponding to a 2nd embodiment of this invention] transverse direction flows, and; drawing 10, Are the outline sectional view which met the A-A line in the nozzle region of drawing 1 A after demarcation of the oxide block for a transverse direction flow, and; drawing 11, Are the outline sectional view which met the B-B line in the nozzle region of drawing 1 A after demarcation of the oxide block for a transverse direction flow, and; drawing 12, Are the

outline sectional view which met the A-B line in the nozzle region of drawing 1 A after demarcation of the oxide block used for a transverse direction flow, and; drawing 13, Are the outline sectional view which met the B-B line in the nozzle region after deposition of flattening of a sacrifice layer, passivation, and a heater layer, demarcation, and formation of a nozzle boa, and; drawing 14 The deposition [of flattening of a sacrifice layer, passivation, and a heater layer], demarcation, and formation back of a boa, Are the outline sectional view which met the A-B line in a nozzle region, and; drawing 15, The ink channel in silicon wafer demarcation-and etching, and removal back of a sacrifice layer, Although it is the outline sectional view which met the A-B line in a nozzle region, it is a figure showing the crowning and pars-basilaris-ossis-occipitalis heater which lower the operating temperature of the heater corresponding to this invention, and increase the deviation of a jet stream and; drawing 16 is the same as that of the thing of drawing 15, Are the outline sectional view which met the B-B line, and; drawing 17, Are some perspective views of the CMOS/MEMS print head, and rib structure and oxide blocking structure are shown, and; drawing 18, Are the perspective view which oxide blocking structure approached, and; drawing 19, With the printer medium (for example, paper) roll under an ink jet printing head, are the example of a continuation ink jet printing head and a nozzle array the shown outline perspective view, and; drawing 20, It is a perspective view of the provided CMOS/MEMS print head on the supporting board to which it is manufactured by this invention and ink is sent.

[0026]Especially this explanation is aimed at the element which forms some devices by this invention, or collaborates its device and directly. or [not being shown in particular] -- or it should understand the element which is not indicated that it is very good for a person skilled in the art in well-known various modes.

[0027]The numerals 10 show the continuation ink jet printer system to drawing 19. Although the array of the nozzle 20 is extending the print head 10a from there, the heater control circuit is incorporated (not shown).

[0028]A heater control circuit reads data from an image memory, and sends a time series electrical signal to the heater of the nozzle array 20. These pulses are impressed by the suitable nozzle during the suitable time of length, and the drops formed from the continuation ink jet stream form a spot on the recording medium 13 in the suitable position directed to the data sent by it from the image memory. the pressurized ink progressing to the ink sending channel formed in the member 14 from ink ****** (not shown), and passing along the nozzle array 20 -- either the recording medium 13 or the throat opening 19 -- it progresses upwards. The ink throat opening 19 is constituted so that the ink DOROPU let 11 which is not deflected may be caught, and on the other hand, the deflected DOROPU let 12 reaches a recording medium. General explanation of the continuation ink jet printer system of drawing 19 is suitable also in order to use as a general statement about the printer system of this invention.

[0029]The top view of the ink jet printing head by this invention is shown in drawing 1. The print head is provided with nozzle array 1a-1d arranged line form or zigzag. Each nozzle is addressed by a logic circuit and the logic AND gates 2a-2d containing a heater drive transistor (not shown), respectively. If both each signal about each data input lines 3a-3d and each enabling clock lines 5a-5d connected to a logic gate are the logic 1 (ONE), a logic circuit will make each driver transistor one. The signal on an enabling clock line (5a-5d) determines the duration time of current via the heater in special nozzle

1a-1d. It may obtain from the processed image data into which the data which drives a heater driver transistor is inputted by the shifting-data register 6. Latch register 7a-7d which answers a latch clock, The signal on line 3a-3d showing each latch condition signal (the logic 1 or zero (ZERO)) with which that a dot is printed on a receiver (image receiving medium) expresses either is provided in response to the data from each shift register stage. In the 3rd nozzle, line A-A and B-B demarcate the direction of the section shown in drawing 1 A and drawing 1 B.

[0030]Drawing 1 A and drawing 1 B are the detailed top views of the heater (respectively [a "notch type" or a "split type"]) of two types used by a CIJ print head. They generate unsymmetrical heating of a jet and cause an ink jet deviation. It means that unsymmetrical heat grant supplies current to some section of a heater independently only in the case of a split type heater. When it is the notch type heater with which current was given to the notch type heater, unsymmetrical heating of meniscus is included essentially. The top view of the ink jet printing head nozzle which has a notch type heater in drawing 1 A is shown. A heater is formed near the exit of a nozzle. Heater element material surrounds a nozzle boa substantially except for sufficient, very small notch-die field which is a grade in which electric opening of traffic is possible. Reference of drawing 1 will connect the 1 side of each heater to the common bus line usually connected to a +5-volt power supply. A side other than each heater is connected to the logic AND gate which equips the inside with the MOS transistor driver who can send the current up to 30 mA to a heater. An AND gate has two logic inputs. the logic input of 1 -- between the present line time or ** -- it is a thing from latch 7a-7d which acquires the information from each shift register stage which shows whether specific heaters are started at the other time. The input of another side is an enabling clock which determines the length and the sequence of time of a pulse which are given to specific heaters. Usually, there are 2 or three or more enabling clocks in the print head, and by it, a contiguity heater can be started at time to differ slightly, and can avoid heat and other cross talk effects.

[0031]By drawing 1 B, it is a split type heater and the nozzle provided with the heater with which the surroundings of the nozzle boa near the outlet opening have two semiconductor heater elements substantially is shown. The half a yen each upper part and a lower segment are equipped with the independent conductor. In this case, meaning the element (member) in the same field as the upper part and the lower part should understand. It has beer which contacts electrically the metal layer relevant to each of these conductors in a conductor. These metal layers are connected to the drive (driver) circuit formed on the silicon substrate so that it might indicate below.

[0032]The outline sectional view of the nozzle which is operating in alignment with B-B is shown in drawing 2. As mentioned above, it has an ink channel which supplies ink under a nozzle. This ink supply is usually performed under the pressure between 15 to 25 psi to a boa diameter of about 8.8 micrometers. The ink of a delivery channel is emitted from it having been pressurized and collecting (not shown), and pours ink to a channel under a pressure. The ink pressure adjustment machine (not shown) was used and constant pressure is secured. The jet which flows into a throat opening directly straightly forms without an influx of the current to a heater. On the surface of the print head, meniscus symmetrical with the surroundings of each nozzle with a diameter larger several micrometers than a boa forms. If a current pulse is impressed to a heater, the meniscus by the side of heating will be pulled, and it will deviate so that a jet may

estrange from a heater. The DOROPU let to form ranks second, bypasses a throat opening, and reaches a receiver. When the current which passes along a heater is returned to zero, it becomes again symmetrical [meniscus] and the direction of a jet is a straight line. Printing is carried out on the receiver which has the DOROPU let which is not deflecting the DOROPU let which the device (device) operated conversely easily, namely, was deflected toward a throat opening. It is not necessarily indispensable to have all the nozzles on the line of 1. It is easier than what has the zigzag edge reflecting a zigzag nozzle configuration to make the throat opening of straight edge substantially.
[0033]In the usual operation, resistance of a heater is about 400-ohm order, and current is 10 mA to 20 mA, Pulse length is about 2 microseconds, and the deflection angle over pure water is an order of abundance, and about this point. The U.S. Pat. No. 6,213,595 specification of the name of an invention of "Continuous Ink Jet Print Head Power-Adjustable Segmented Heater", And please refer to the U.S. Pat. No. 6,217,163 item specification of the name of an invention of "Continuous Ink Jet Print Head Having Multi-Segment Heaters." It applies for all on December 28, 1998.
[0034]Impression of a periodic current pulse will decompose a jet into simultaneous DOROPU let according to impress pulses. From the surface of the print head, such DOROPU let leaves 200 micrometers, is 8.8 micrometers in diameter, is about 2-microsecond width, and is 200-kHz pulse ratios from about 100 micrometers, and these are usually the sizes of 3pL to 4pL.
[0035]A nozzle is an imperfect stage of formation of the print head behind formed by an array, and the sectional view in alignment with line A-B shown in drawing 3 shows the stage where a CMOS circuit is accumulated on the same silicon substrate.
[0036]As mentioned above, a CMOS circuit is first formed on a silicon wafer. A CMOS process may be a standard 0.5-micrometer mix-signals process which incorporated two levels of polysilicon, and three metaled levels on the 6-inch diameter wafer. Wafer thickness is usually 675 micrometers. The metal of three layers it was indicated that connected internally from beer expresses this process to drawing 3. It is drawing in order to show an active circuit [in / for the N^+ diffusion and contact to the polysilicon level 2 and the metallic level 1 / a silicon substrate]. The gate of a CMOS transistor may be formed in a polysilicon layer.
[0037]For the necessity of insulating a metal layer electrically, a dielectric layer is deposited among those metal layers so that all the thickness of the film on a silicon wafer may be set to about 4.5 micrometers.
[0038]Fundamentally, the structure shown by drawing 3 provides a required transistor and logic gate, in order to provide a control element as shown by drawing 1.
[0039]As the result of the conventional CMOS formation stage. The silicon substrate of a diameter 6-inch diameter is obtained at about 675 micrometers in thickness. It is large texture more or the silicon wafer of a smaller diameter can be used similarly. As everyone knows, in order to form these transistors, it lets the conventional method of depositing on various materials selectively pass, and two or more transistors are formed in two or more transistors at a silicon substrate. A series of layers which will form the oxide / nitride insulating layer which has 1 or 2 or more polysilicon layers and the metal layer formed there corresponding to the desired pattern are supported on a silicon substrate. In order to make it accessible to a metal layer in order to have beer among various layers needed and to have a bond pad, the surface may be beforehand equipped

with an opening. In order to make each connection with the electric power supplied from the circuit board connected to the print head from whether it prepared for data, a latch clock, an enabling clock, and the metal of the print head, and the estranged position, it has various bond pads. As drawing 3 showed, an oxide / nitride insulating layer is about 4.5-micrometer thickness. Fundamentally, the structure shown by drawing 3 is provided with required internal connection, a transistor, and a logic gate, in order to have the control component shown by drawing 1.

[0040]As shown in drawing 4 which was the same as that of the figure of drawing 3, and met the A-B line, the mask was stuck on the right face (front surface) of the wafer, and has demarcated a window 22 micrometers in diameter. Subsequently, it etches to the silicon surface which suspends etching as showed the dielectric layer of the window by drawing 4.

[0041]As shown in drawing 5, many stages are shown in this figure. The 1st phase is filling up with an amorphous or sacrifice layer like polyimide the window opened in the front stage. A sacrifice layer is deposited on the hollow formed between the right face of an oxide / nitride insulation layer, and the silicon substrate. These films are deposited at the temperature of 450 ** or less, in order to prevent fusion of the existing aluminum layer.

[0042]Next, about 3,500 A [like Si_3N_4 of PECVD] thin protective layer is deposited, and the opening of the beer 3 is further carried out to three metal layers. Beer is filled up with W, and flattening can be carried out, and they can be etched with the side attachment wall which has an inclination, carry out direct contact of the heater layer deposited on the next by it to the metal layer 3, and can do things. About 50-A Ti and the heater layer which comprises about 600-A TiN are deposited, and, subsequently it patterns. Next, the last thin protection (passivation is usually called) layer is deposited. As a layer under a heater, a heater is protected from the corrosive action of ink, ink does not become dirty easily, and this layer needs to have the character which can be defecated easily, when it becomes dirty. It acts as a protective layer also to mechanical wear.

[0043]The mask for forming a boa is stuck on the next, a passivation layer is etched, and the opening of a boa and the connection pad is carried out. Drawing 5 shows the sectional view of the nozzle in this stage. Etching a nozzle boa simultaneously along Silicon Alley should understand.

[0044]Subsequently, as a silicon wafer is made thin from 675 micrometers to 300 micrometers of initial thickness and it was shown in drawing 6, the mask for subsequently carrying out the opening of the ink channel is attached to the reverse side side of a wafer, and silicon is etched to the right face of silicon in STS machining by etching. Then, a sacrifice layer is etched from a reverse side side, and by it, as drawing 6 showed, it becomes a final device. As shown in drawing 6, a device has the flat outermost surface so that it can defecate easily, a boa is narrow enough and a jet deviation increases. The temperature after processing is maintained at 420 ** or less of the annealing temperature of a heater, and the resistance is uniformly held by it for a long time. The buried heater element surrounds a nozzle boa effectively, and approaches a nozzle boa dramatically so that drawing 6 may show.

[0045]Other features of the print head as shown by drawing 6 are having the pars-basilaris-ossis-occipitalis polysilicon layer extended to the ink channel formed in the oxide layer, and providing a polysilicon heater element. A pars-basilaris-ossis-occipitalis

heater element is used for ink giving initial preheating of the ink at the time of going into the channel section of an oxide layer. This modification structure is formed between CMOS processes.

[0046]Although shown in drawing 7, the ink channel formed in the silicon substrate is a rectangle cavity prolonged in the center under a nozzle array. However, when the long cavity of the center of a die tends to weaken a print head array structurally, therefore an array twists it like [when it is mounting (packaging)] and it is easy to receive stress, a film breaks easily. Along with the print head, the pressure fluctuation of the ink channel by a low frequency pressure wave may produce a jet jitter. What was shown is the improved version. This improvement design comprises leaving behind the silicon bridge between each nozzle of the nozzle array between etching of an ink channel, or a rib. These bridges have extended to the bow from the reverse side of a silicon wafer. Therefore, the ink channel which was demarcated and was patterned after the reverse side side of the wafer is not the long rectangle hollow that already extends in parallel with the direction of a nozzle row but a smaller rectangle cavity group of a series which provides a single nozzle respectively. In order to reduce a flow resistance, each ink channel is formed so that it may become in the direction which intersects perpendicularly with 20 micrometers and a nozzle row in accordance with the direction of a nozzle row with the rectangle of 120 micrometers.

[0047]In an improvement design, a silicon wafer is made thin from 675 micrometers to 300 micrometers of initial thickness. Subsequently, the mask for the openings of an ink channel is attached to the reverse side side of a wafer, and silicon is etched to the right face of silicon in STS machining by etching. The used mask is left behind behind the silicon bridge between each nozzle of a nozzle array, or a rib during etching of an ink channel. These bridges have extended to the bow from the reverse side of a silicon wafer. Therefore, the ink channel which was demarcated and was patterned after the reverse side side of the wafer is not the long rectangle hollow that already extends in parallel with the direction of a nozzle row but a smaller rectangle cavity of a series which provides a single nozzle respectively. When the intensity of silicon is improved, therefore an array twists like in the case of mounting contrary to the long cavity in the center of the die which has a tendency which weakens the print head structurally and it is easy to receive stress by use of these ribs, a film breaks easily. The pressure fluctuation of the ink channel by a low frequency pressure wave may produce a jet jitter to the long print head.

[0048]As for a jet deviation, as mentioned above about the CIJ printing system, increasing further is more desirable by increasing the quantity of some ink which goes into a nozzle boa with lateral quantity of motion than shaft orientations. This can be carried out by blocking some fluids which have the amount of axial motion by building a block in the center section of a nozzle orifice or each nozzle array structure [directly under] of a boa.

[0049]Although the nozzle array by a 2nd embodiment of this invention which has rib structure is formed, the method by which transverse direction flow structure is characterized is explained. Drawing 3 shows the section of a silicon wafer near the nozzle in the end of the above CMOS formation sequences. Although the following paragraphs explain to formation of a single nozzle, it should understand for a process to be able to apply as well as a series of nozzle groups formed in the sequence along with the wafer. The 1st phase in the sequence after processing is attaching a mask to the bow of a wafer

to the field of each nozzle orifice formed. A mask is formed so that the semiconductor opening of a concentric 6-micrometer width of two pieces may be opened to the nozzle boa formed with an etching reagent. The outer tip of these openings corresponds to a 22-micrometer diameter circle. Subsequently, the dielectric layer in a semiconductor region is thoroughly etched to a silicon face, as shown in drawing 9. The 2nd mask is attached and selective etching of the oxide block shown by drawing 10 is made into the shape made possible. When etching with the 2nd mask of a proper place, an oxide block is etched to the final thickness or the height from about 1.5-micrometer silicon substrate, as drawing 11 showed to the section which met drawing 10 and profile line A-A to the section in alignment with profile line B-B. Along with A-B, the section of a nozzle region is shown in drawing 12.

[0050]Then, the opening of a dielectric layer is filled up with an amorphous silicon or a sacrifice layer like polyimide, and flattening of the wafer is carried out.

[0051]Next, a thin 3500A protective film like Si_3N_4 or the inactivation (passivation) layer of PECVD is deposited, it ranks second and the opening of the beer 3 to the level (mtl3) of the metal 3 is carried out. Please refer to drawing 14. Subsequently, all the wafers top is covered by a Ti/TiN thin layer, and it covers in still thicker W layer. Subsequently, flattening of the surface is carried out in the chemical machinery polish process of removing W (tungsten) layer, and Ti/TiN layer from all except the beer 3. The beer 3 can be etched so that it may have a side attachment wall which has inclination, and it can carry out direct contact of the heater layer deposited on the next by it to the layer of the metal 3. The heater layer which comprises about 50 A and TiN about 600A deposits Ti, and, subsequently it is patterned. Subsequently, the last thin protection (usually called passivation) layer is deposited. When this layer has the characteristic which protects a heater from the corrosion action of ink, and it must not become dirty easily in ink and it becomes dirty, it must be easily made to clarification. It also provides the protection to machinery wear and has a desired angle of contact to ink. In order to satisfy these all demand, a passivation layer comprises lamination of the film of a different material. Thickness of the last film which surrounds a heater It is about 1.5 micrometers. The bow of a wafer is adjoined, a boa mask is attached, a passivation layer is etched, and a boa is opened to each nozzle and a bond pad. Drawing 13 and drawing 14 show each sectional view of each nozzle in this stage. Although the bond pad of the individual is shown uniquely, that a multiplex bond pad is formed in a nozzle array should understand. In order to combine the power supplied from the position which is separated from the circuit board which adjoined data, a latch clock, an enabling clock, and the print head, and was attached, respectively, it has various bond pads.

[0052]Subsequently, a silicon wafer is made thin in thickness of about 300 micrometers from 675-micrometer initial thickness. Subsequently, the mask which carries out the opening of the ink channel is attached to the rear face of a wafer, and, subsequently silicon is etched to the right face of silicon by a STS deep silicon dirty system. Eventually, a sacrifice layer etches from a rear face and a right face, and serves as the last device (device) shown by drawing 15, drawing 17, and drawing 18. Alignment to the nozzle array in the bow of a wafer of the ink channel opening in the reverse side of a wafer may be performed using an aligner system like a curl ZUSU 1X aligner system.

[0053]As drawing 15 and drawing 16 showed, a polysilicon type heater is incorporable into the pars basilaris ossis occipitalis of dielectric lamination of each nozzle. These

heaters also contribute to reducing the viscosity (viscosity) of ink asymmetrically. As shown in drawing 16, the ink flow which passes along the access opening on the right-hand side of blocking structure is heated, but the ink flow which passes along the access opening on the left-hand side of blocking structure is not heated. Unsymmetrical preheating (heating which preceded) of this ink flow, It becomes the tendency to reduce the viscosity of the ink which has the transverse direction quantity-of-motion ingredient desired to the deviation, and since the further ink flows so that viscosity may be reduced, there is a big tendency to deflect ink, in the direction of desired, for example, the direction estranged from the heater element near the boa. Polysilicon type heater elements may be the composition of the preheating element close to a boa, and the same composition. A heater falls dramatically the temperature to which each heater operates at the place used at both the upper part of each nozzle boa, and the pars basilaris ossis occipitalis, as these figures showed. The reliability of a TiN heater improves considerably, when they can operate at a temperature sufficiently lower than annealing temperature.

[0054]As shown in drawing 11, the ink which flows into a boa is governed by the desired transverse direction quantity-of-motion ingredient to the increase in a DOROPU let deviation.

[0055]During etching of an ink channel, etching of the silicon substrate went so that it might remain behind the silicon bridge between the nozzles of a nozzle array, or a rib. These bridges have extended to the bow from the reverse side of a silicon wafer. Therefore, the ink channel which was demarcated and was patterned after the reverse side side of the wafer is a smaller rectangle cavity group of a series which provides a single nozzle respectively. In order to reduce a flow resistance, each ink channel is formed so that it may become in the direction which intersects perpendicularly with 20 micrometers and a nozzle row in accordance with the direction of a nozzle row with the rectangle of 120 micrometers. An ink cavity is provided with the 1st ink channel formed in the silicon substrate, and the 2nd ink channel formed in the oxide/nitride layer, respectively, and these 1st and 2nd ink channels are open for free passage via the access opening formed in the oxide/nitride layer. These access openings need for ink to flow under the pressure between the 1st ink channel and the 2nd ink channel, and increase a crosswise flow component. It is because shaft-orientations access to the 2nd ink channel is directly blocked with an oxide block effectively.

[0056]As shown in drawing 18, the completed CMOS/MEMS print head 120 corresponding to either of the embodiments written in this specification, It is attached on the supporting mount 110 which has the ink supply lines 130L and 130R of the couple combined with the contiguity end of the mount for supplying ink to the end of the channel prolonged in the major axis direction formed in a supporting board or mount. A channel meets behind the print head 120 and is open for free passage to all the ink channels formed in the silicon substrate of the print head 120. Supporting mount includes a mounting hole in an end, in order to attach this structure to a printer system.